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(54) **OPTICAL PICKUP DEVICE**

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G11B 7/1374	(2012.01)
G11B 7/085	(2006.01)
G11B 7/09	(2006.01)
G11B 7/095	(2006.01)

(52) **U.S. Cl.**

CPC ***G11B 7/1374*** (2013.01); ***G11B 7/08582*** (2013.01); ***G11B 7/0932*** (2013.01); ***G11B 7/0935*** (2013.01); ***G11B 7/0956*** (2013.01)

(58) **Field of Classification Search**

CPC G11B 7/08582; G11B 7/0927; G11B 7/0929; G11B 7/0932; G11B 7/0933; G11B 7/0935; G11B 7/0956; G11B 7/121

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,929,385 B2 * 4/2011 Fujiwara G11B 7/0937 369/44.15
2001/0055265 A1 12/2001 Obara
2007/0171777 A1 * 7/2007 Takahashi G11B 7/0935 369/44.15
2008/0037383 A1 * 2/2008 Suzuki G11B 7/121 369/44.14
2008/0077946 A1 * 3/2008 Suetsugu G11B 7/22 720/600

FOREIGN PATENT DOCUMENTS

JP 2001-319342 11/2001

* cited by examiner

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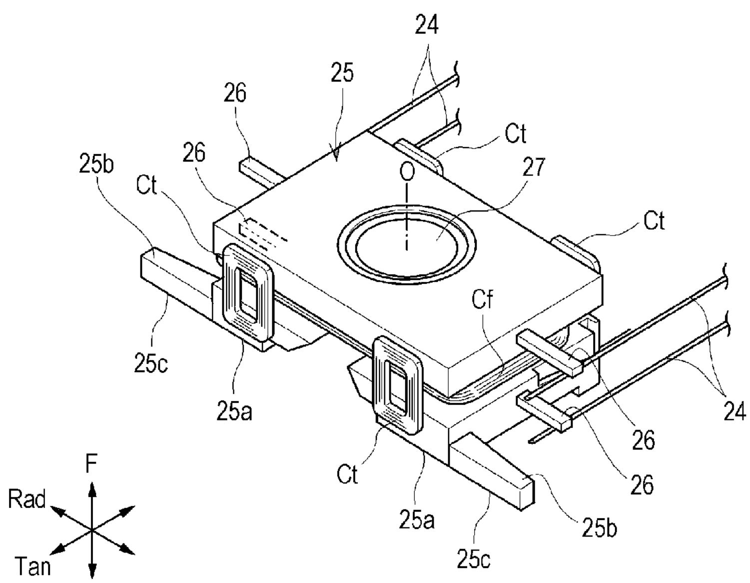
(57) **ABSTRACT**

An optical pickup device is one in which a lens holder is held by a movable base by using a resilient wire. A restricting abutting portion is formed at a lower portion of the lens holder. When the lens holder moves excessively downward, the restricting abutting portion comes into contact with a stopper portion to restrict a downward movement of the lens holder, so that it is possible to prevent the lens holder from contacting a unit chassis. When the unit chassis is not mounted on the movable base, it is possible to prevent excessive flexing of the resilient wire caused when an opposing abutting portion of the lens holder comes into contact with the unit chassis.

16 Claims, 4 Drawing Sheets



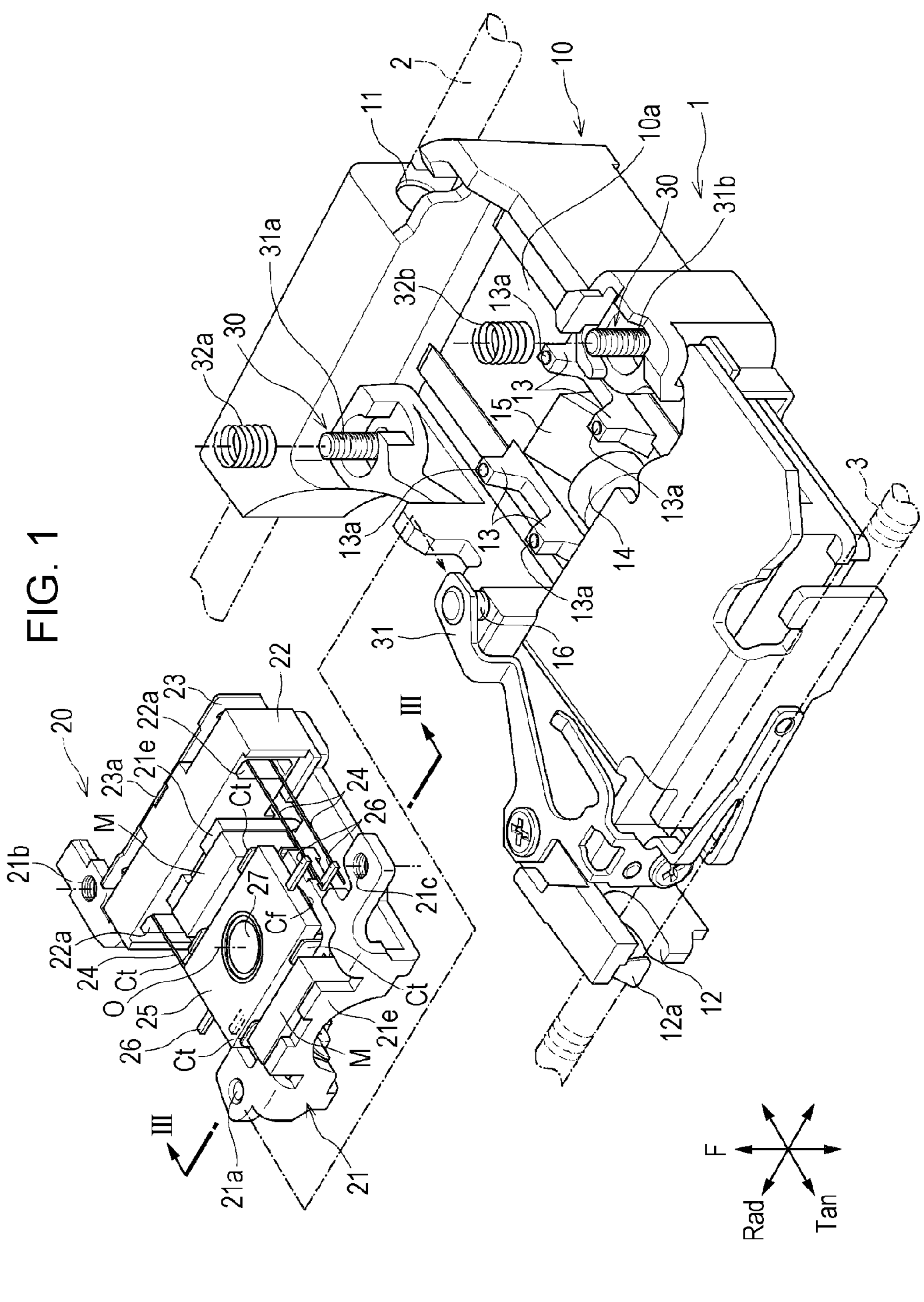


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FIG. 1

FIG. 2

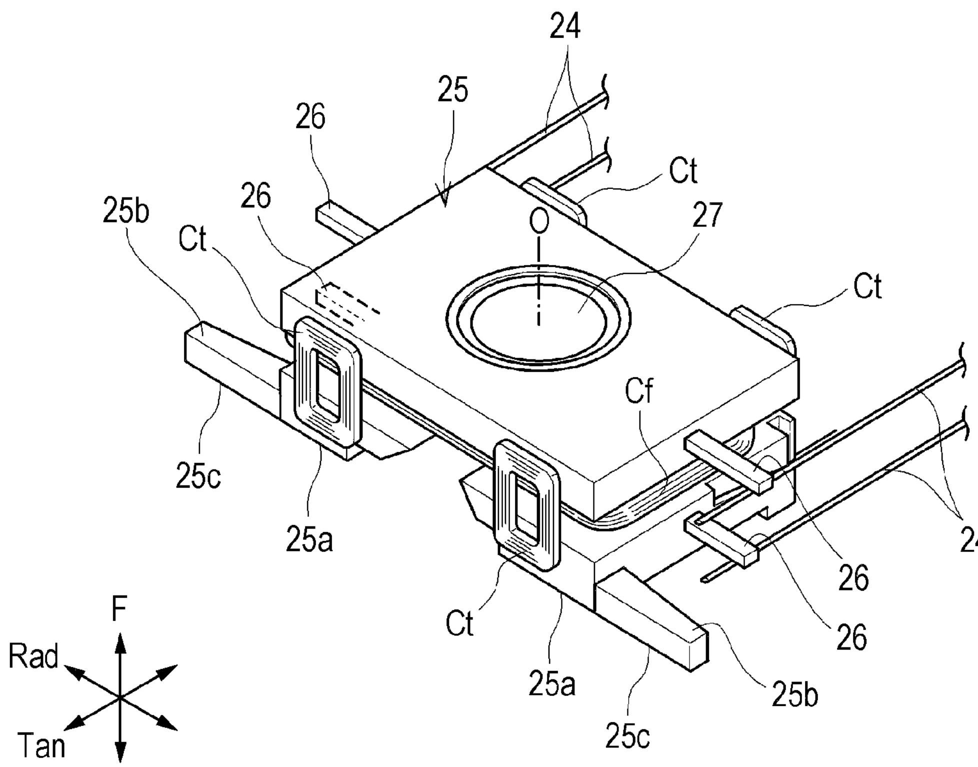
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FIG. 3

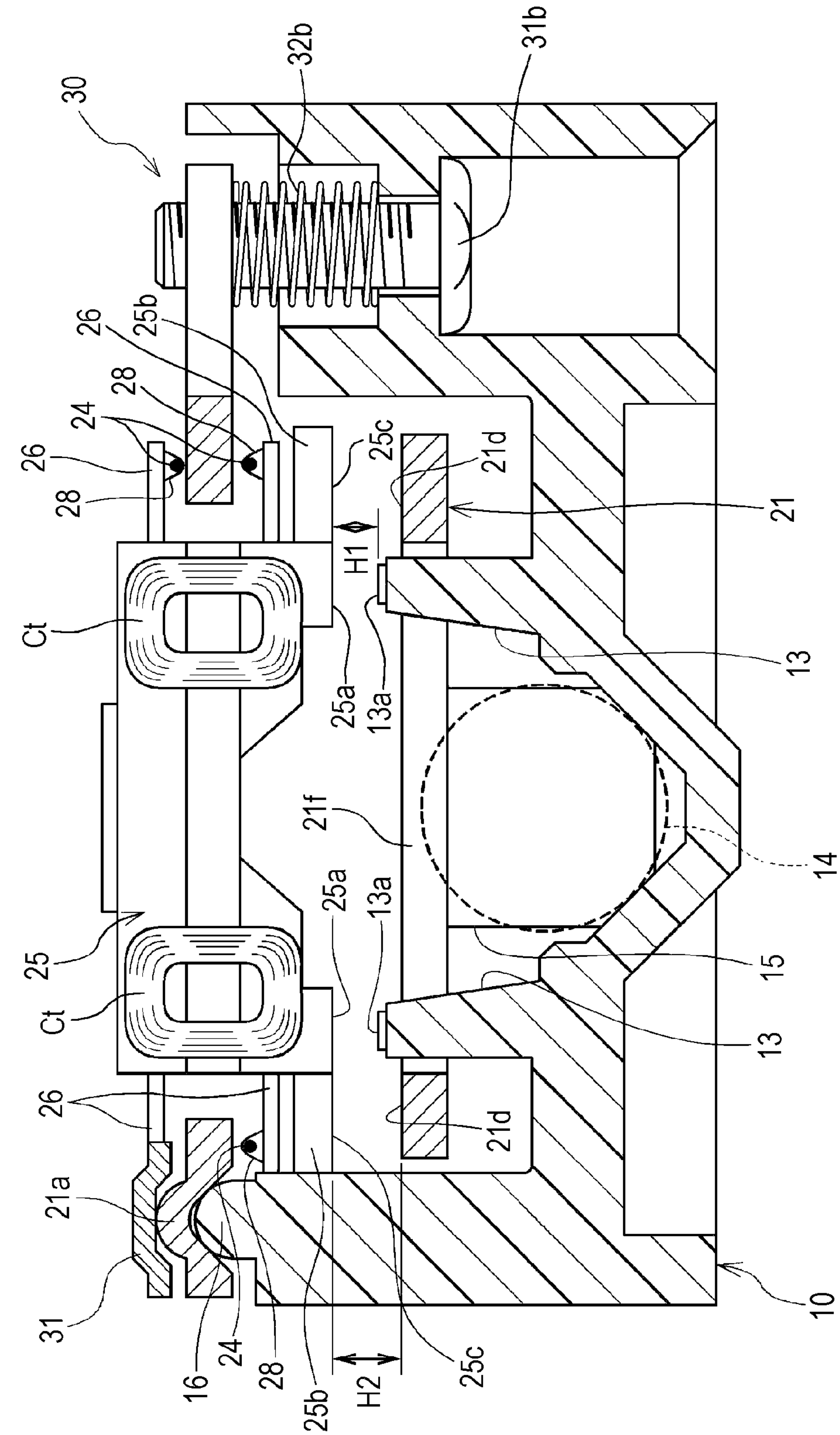
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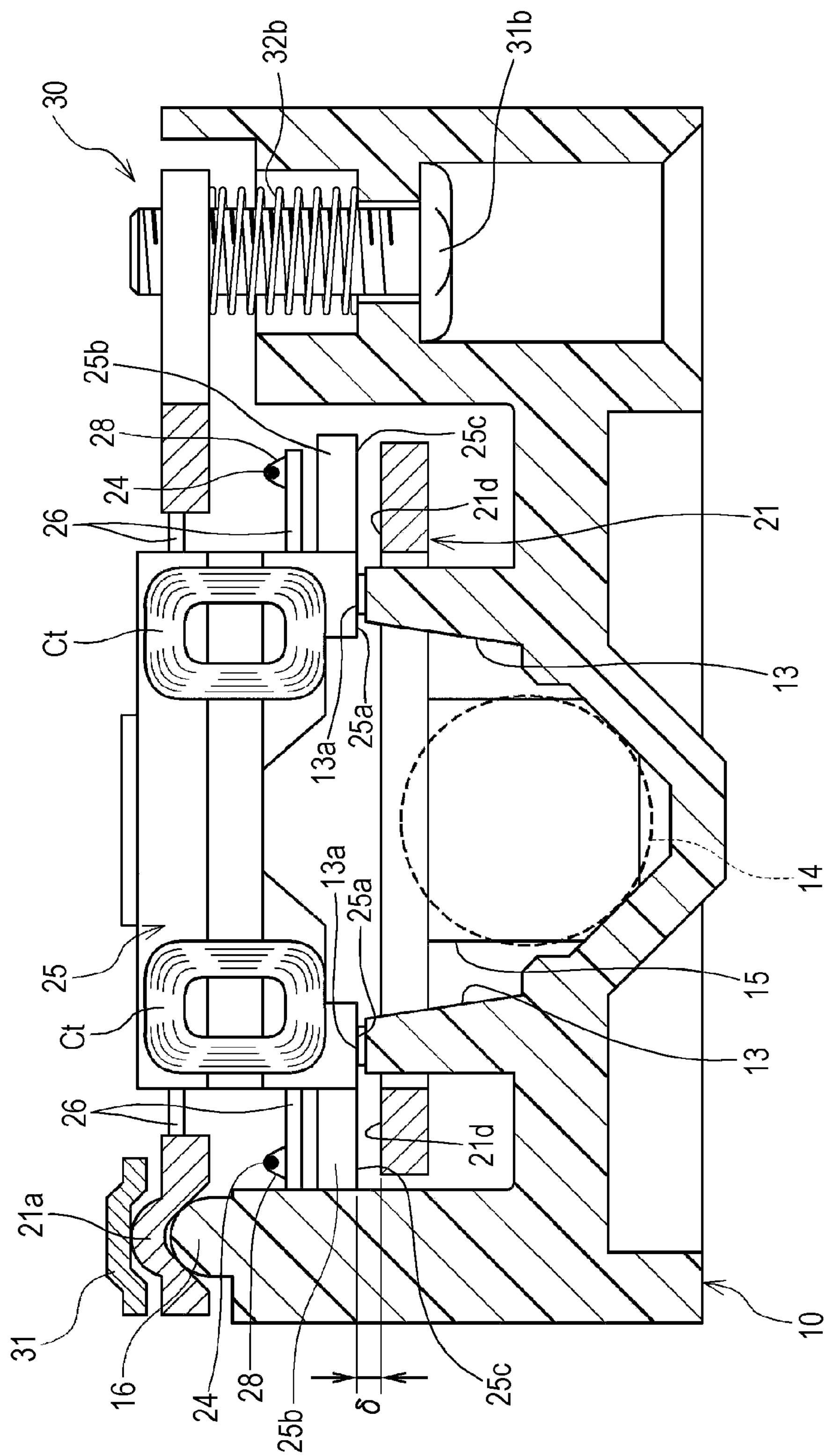
FIG. 4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OPTICAL PICKUP DEVICE

RELATED APPLICATION

The present application claims priority to Japanese Patent Application Number 2014-145629, filed Jul. 16, 2014, the entirety of which is hereby incorporated by reference.

BACKGROUND

1. Field of the Invention

The present disclosure relates to an optical pickup device having a structure in which a lens driving unit is mounted on a movable base, the lens driving unit including, for example, a lens holder and a focus correcting mechanism.

2. Description of the Related Art

An optical pickup device that reproduces information from various types of recording media, such as CDs or DVDs, includes a movable base that moves along a recording surface of a disk, with a lens driving unit being mounted on the movable base. The lens driving unit is provided with a unit chassis. A tilt adjusting mechanism that adjusts the tilt of the lens driving unit is provided between the unit chassis and the movable base.

In the lens driving unit, mounted at the unit chassis are a lens holder that holds an objective lens opposing a disk, a resilient supporting member that movably supports the lens holder, a focus correcting mechanism that moves the lens holder in a direction of an optical axis of the objective lens, and a tracking correcting mechanism that moves the lens holder in a radial direction that is orthogonal to the optical axis.

In an optical pickup device described in Japanese Unexamined Patent Application Publication No. 2001-319342 (Patent Literature (PTL) 1), four resilient wires that extend in a direction that is orthogonal to an optical axis of an objective lens are used as resilient supporting members. Base portions of the resilient wires are secured at a base member corresponding to a unit chassis. A lens holder is secured to end portions of the resilient wires. In this structure, by resiliently flexing the resilient wires, the lens holder is movable in a focus correction direction and a tracking correction direction.

The optical pickup device described in PTL 1 includes a stopper at a bottom portion of an optical chassis corresponding to the movable base. The stopper opposes a bottom portion of the lens holder through a through-hole formed in the base member. When the lens holder moves by a large amount in a direction opposite to a disk, the bottom portion of the lens holder passes through the through-hole and comes into contact with the stopper, to allow the amount of movement of the lens holder to be restricted.

Since the optical pickup device described in PTL 1 has a structure in which only the optical chassis opposes a lower portion of the lens holder, the optical pickup device can be made thin.

The optical pickup device described in PTL 1 has a structure in which the bottom portion of the lens holder and the stopper of the optical chassis come into contact with each other via the through-hole formed in the base member. Therefore, in a step that is executed after, for example, the resilient wires, the lens holder, and the focus correcting mechanism have been mounted on the base member and before the base member is mounted at the optical chassis, if an external force accidentally acts upon the lens holder, the resilient wires may become excessively bent due to the movement of the lens holder to a position where it passes the inside of the through-hole. If the flexing amount of the resilient wires at this time goes beyond a resilience region and exceeds a yield point, the resilient wires undergo plastic deformation and become defective wires that are incapable of functioning.

In contrast, if the aforementioned through-hole is not provided and a portion of the lens holder is caused to contact the base member when the lens holder is pushed by an external force, it is possible to prevent the resilient wires from flexing by an abnormally large amount. However, the use of such a structure gives rise to new problems such as those described below.

When the lens holder is to be mounted at the base member, it is desirable that the lens holder be secured to the resilient wires after an optical axis center of the objective lens held by the lens holder has been positioned with respect to the base member using an adjusting jig with the base portions of the resilient wires being secured at the base member first. Since the resilient wires are also used as energization paths to coils provided at the lens holder, in general, ordinarily the resilient wires and metallic terminals, which are mounted in the lens holder, are soldered to each other, and the resilient wires and the lens holder are secured to each other by the adhesive force of the solder.

Here, if, during the soldering, flux adheres to a surface of the base member, when a completed optical pickup device is used in a high-temperature environment, the flux is heated and becomes adhesive, as a result of which the lens holder tends to adhere to the surface of the base member by the flux.

In this type of optical pickup device, when a new disk has been loaded, while the focus correcting mechanism moves the lens holder by a large amount in a direction away from the disk and, from this position, moves the lens holder towards the disk, the objective lens causes detection light to converge on a recording surface of the disk and return light thereof is detected, so that, for example, detection of the presence or absence of the disk or detection of the disk type, such as a CD or DVD, is performed. During this operation, if the lens holder even temporarily adheres to the base member, an error occurs in the aforementioned detections. This causes an erroneous determination that the disk does not exist or malfunctions, such as a discharge of the disk to the outside of the optical pickup device without identifying the disk type.

In order to prevent the adhesion of flux to the base member, a method for mounting the resilient wires at the base member after soldering the resilient wires to the lens holder may be considered. However, when the resilient wires that are secured to the lens holder are to be mounted at the base member, it is difficult to position with high precision the optical axis of the objective lens held by the lens holder with respect to the base member.

SUMMARY

Accordingly, it is an object of the present disclosure to provide an optical pickup device that does not allow a lens holder to adhere to a unit chassis even if flux or the like adheres to the unit chassis and that is capable of preventing a resilient supporting member from being excessively deformed in any step.

According to the present disclosure, there is provided an optical pickup device including a movable base and a lens driving unit that is supported by the movable base. The lens driving unit includes a unit chassis, a lens holder, a resilient supporting member, and a focus correcting mechanism. The lens holder, the resilient supporting member, and the focus correcting mechanism are provided at the unit chassis. The lens holder holds an objective lens that opposes a recording medium. The resilient supporting member supports the lens

holder. The focus correcting mechanism moves the lens holder in a direction of an optical axis of the objective lens. The lens holder includes a restricting abutting portion and an opposing abutting portion. When the lens holder moves in a direction away from the recording medium, the restricting abutting portion comes into contact with the movable base to restrict further movement of the lens holder. When the lens holder moves in the direction away from the recording medium, the opposing abutting portion moves closer to the unit chassis, and, when the restricting abutting portion comes into contact with the movable base, the opposing abutting portion opposes the unit chassis with a gap between the opposing abutting portion and the unit chassis.

In the optical pickup device according to the present disclosure, it is desirable that a positional relationship between the opposing abutting portion and the unit chassis be determined such that, when the opposing abutting portion and the unit chassis come into contact with each other in a state in which the lens driving unit is not mounted on the movable base, an amount of deformation of the resilient supporting member is within a resilience region of the resilient supporting member.

In the optical pickup device according to the present disclosure, it is desirable that a plurality of the resilient supporting members be provided, the plurality of resilient supporting members be a plurality of resilient wires that extend in a direction that crosses the direction of the optical axis, a base portion of each resilient wire be secured at the unit chassis, and an end portion of each resilient wire and the lens holder be soldered and secured to each other.

The optical pickup device is effective such that, in a state in which the base portion of each resilient wire is secured at the unit chassis, the lens holder is positioned at the unit chassis, and the end portion of each resilient wire and the lens holder are soldered to each other.

In the optical pickup device according to the present disclosure, it is desirable that the movable base include a stopper protrusion that comes into contact with the restricting abutting portion, the unit chassis include a receiving portion that opposes the opposing abutting portion, and an end portion of the stopper protrusion be positioned closer to the lens holder than the receiving portion.

The optical pickup device according to the present disclosure may further include a tilt adjusting mechanism that is disposed between the movable base and the unit chassis, the tilt adjusting mechanism adjusting an amount of tilt of the optical axis of the objective lens.

According to the optical pickup device of the present disclosure, the opposing abutting portion of the lens holder opposes the unit chassis in a state in which the lens holder and the resilient supporting member are mounted at the unit chassis. Therefore, even if a large external force acts upon the lens holder during the time until the lens holder is mounted on the movable base, excessive deformation of the resilient supporting member caused by contact of the opposing abutting portion with the unit chassis can be prevented from occurring.

Next, if the focus correcting mechanism moves the lens holder in a direction opposite to a recording medium when the lens driving unit has been mounted on the movable base, the amount of movement of the lens holder can be restricted by causing the restricting abutting portion of the lens holder to contact the movable base. At this time, even if the restricting abutting portion contacts the movable base, the opposing abutting portion of the lens holder does not contact the unit chassis. Therefore, even if flux used for solder adheres to the lens holder, the problem that the lens holder adheres to the unit chassis in a high-temperature environment no longer occurs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of an optical pickup device according to an embodiment of the present invention;

FIG. **2** is a partial perspective view of a structure of a lens holder that is supported by resilient supporting members;

FIG. **3** is a sectional view of the optical pickup device along line III-III and illustrates a state in which the lens holder is in a neutral position; and

FIG. **4** is a sectional view of the optical pickup device along the line III-III and illustrates a state in which the lens holder has moved downward.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An optical pickup device **1** according to an embodiment of the present invention shown in FIG. **1** is mounted on an optical disk device. The optical disk device includes a turntable. Various types of optical disks (recording media), such as a CD or a DVD, are placed on the turntable and rotationally driven. The optical pickup device **1** reproduces information recorded on a recording surface of an optical disk or writes information to the recording surface.

The optical pickup device **1** shown in FIG. **1** includes a movable base **10**. The movable base **10** is formed by injection molding with, for example, polyphenylene sulfide (PPS) resin or by die casting with a lightweight metal material, such as aluminum. A reference bearing **11** and a driving bearing **12** are formed in the movable base **10**. At the optical disk device, a guide shaft **2** and a drive screw shaft **3** extend parallel to each other. The reference bearing **11** is slidably inserted onto the guide shaft **2**. An engaging portion **12***a* of the drive bearing **12** engages with a screw groove of the drive screw shaft **3**. When the drive screw shaft **3** is rotationally driven by a thread motor (not shown), the movable base **10** of the optical pickup device **1** moves in a radial direction (Rad) of an optical disk D.

Stopper protrusions **13** protrude upward (in a direction F, which is a focusing direction) integrally from a bottom portion **10***a* of the movable base **10**. Upper end portions of the stopper protrusions **13** are stopper portions **13***a*. The stopper portions **13***a* are provided at four locations.

The movable base **10** functions as an optical base. Various optical components, such as a collimator lens **14** and a prism **15**, are mounted on the movable base **10**. A light emitting element and a light receiving element are provided on an optical axis of the collimator lens **14**.

A lens driving unit **20** is mounted on the movable base **10**. The lens driving unit **20** includes a unit chassis **21**. The unit chassis **21** is formed of a metal plate. The unit chassis **21** is provided with a support reference portion **21***a* and a pair of adjustment internally threaded holes **21***b* and **21***c*. A fulcrum supporting portion **16** that faces upward is formed at the movable base **10**. As shown in FIG. **3**, when the lens driving unit **20** is set on the movable base **10**, the support reference portion **21***a* of the unit chassis **21** is set on the fulcrum supporting portion **16**, and the support reference portion **21***a* is pushed against the fulcrum supporting portion **16** by a leaf spring **31** secured to the movable base **10**.

A tilt adjusting mechanism **30** is provided between the movable base **10** and the unit chassis **21**. In the tilt adjusting mechanism **30**, two adjustment screws **31***a* and **31***b* are inserted in the movable base **10** so as to face upward. The adjustment screw **31***a* is screwed into the adjustment internally threaded hole **21***b* in the unit chassis **21**. The adjustment screw **31***b* is screwed into the adjustment internally threaded hole **21***c*. A compression coil spring **32***a* is provided around the outer periphery of the adjustment screw **31***a*. A compression coil spring **32***b* is provided around the outer periphery of the adjustment screw **31***b*. The compression coil springs **32***a* and **32***b* are interposed between the unit chassis **21** and the movable base **10** in a compressed state.

As shown in FIG. **1**, a supporting member **22** is secured to the unit chassis **21**, and a central portion **23***a* of a supporting substrate **23** is secured to a back portion of the supporting member **22**. Base portions of resilient wires **24** are secured to the supporting substrate **23**. A total of four resilient wires **24** are formed, two at the left end and the other two at the right end of the supporting substrate **23**. The four resilient wires **24** form resilient supporting members. The resilient wires **24** pass through corresponding openings **22***a* in the supporting member **22** and extend parallel to each other in a tangential direction (Tan) of the optical disk D.

The lens driving unit **20** includes a lens holder **25**. The lens holder **25** is formed of synthetic resin or lightweight metal. The lens holder **25** holds an objective lens **27**. As shown in FIG. **2**, of portions of a lower surface of the lens holder **25**, the portion that opposes the stopper portions **13***a* at the upper side of the movable base **10** are restricting abutting portions **25***a*. Two protrusions **25***b* extending towards two sides in the radial direction (Rad) are formed integrally with a lower portion of the lens holder **25**. Lower surfaces of the protrusions **25***b* are opposing abutting portions **25***c*. At an upper surface of a bottom portion of the unit chassis **21**, portions thereof that oppose the opposing abutting portions **25***c* are receiving portions **21***d*.

As shown in FIGS. **1** and **2**, metallic supporting terminals **26** extending towards two sides in the radial direction (Rad) are provided at the lens holder **25**. The metallic supporting terminals **26** are mounted and secured in the lens holder **25**. A focus coil Cf is wound around the lens holder **25**. Tracking coils Ct are provided at two side surfaces of the lens holder **25** oriented in the two tangential directions (Tan), two at one side surface and the other two at the other side surface of the lens holder **25**. A terminal portion of a coil winding of the focus coil Cf is wound around and secured to two of the four metallic supporting terminals **26**. The four tracking coils Ct are connected in series. Terminal portions of coil windings of the tracking coils Ct are wound around and secured to two of the four metallic supporting terminals **26**.

End portions of the resilient wires **24** are soldered and secured to the respective metallic supporting terminals **26**. The lens holder **25** is supported so as to be movable in the radial direction (Rad) and optical-axis direction (F) by the four resilient wires **24** that extend in a direction orthogonal to the direction of an optical axis O. The resilient wires **24** are formed of conductive metal. Due to the soldering, the terminal of the coil winding of the focus coil Cf is brought into conduction with two resilient wires **24**, and the terminals of the coil windings of the tracking coils Ct are brought into conduction with the other two resilient wires **24**. From a drive circuit (not shown), correction drive current is supplied to the focus coil Cf via the corresponding resilient wires **24** and to the tracking coils Ct via the corresponding resilient wires **24**.

As shown in FIG. **1**, a pair of yokes **21***e* and **21***e* of the unit chassis **21** are bent in an integrated manner with the unit chassis **21**. Magnets M are secured to the yokes **21***e* and **21***e*, respectively. The magnets M oppose both the focus coil Cf and the tracking coils Ct, which are mounted on the lens holder **25**.

The focus coil Cf and the magnets M form a focus correcting mechanism. In the focus correcting mechanism, the correction drive current that flows in a radial direction (Rad) through the focus coil Cf and the magnetic fields from the magnets M causes the lens holder **25** to be driven in an optical-axis direction (F).

The tracking coils Ct and the magnets M form a tracking correcting mechanism. In the tracking correcting mechanism, the correction drive current that flows in an optical-axis direction through the tracking coils Ct and the magnetic fields from the magnets M causes the lens holder **25** to be driven in a radial direction (Rad).

The optical pickup device **1** is assembled as follows.

In assembling the lens driving unit **20**, the supporting member **22** is secured to the unit chassis **21**, and the supporting substrate **23** to which the base portions of the four resilient wires **24** are secured is secured to the supporting member **22**. At this time, the four resilient wires **24** pass through the corresponding openings **22***a* of the supporting member **22** and extend in the tangential direction.

The unit chassis **21** is temporarily secured to a holding jig at a die. Using a positioning jig, the lens holder **25** is positioned on the unit chassis **21**. When the position of the lens holder **25** on the unit chassis **21** is determined, the positions of the four resilient wires **24** are determined such that a slight gap exists between the resilient wires **24** and the metallic supporting terminals **26**. When the position of the lens holder **25** is determined, the metallic supporting terminals **26** and the respective resilient wires **24** are soldered to each other. Thereafter, the objective lens **27** is placed on the lens holder **25**. In FIG. **3**, each hardened solder is represented by reference numeral **28**. In this assembly work, after the position of the lens holder **25** at the unit chassis **21** is precisely determined, the metallic supporting terminals **26** and the resilient wires **24** are soldered to each other. Therefore, it is possible to position an optical axis O of the objective lens **27** with respect to the unit chassis **21** with high precision.

The lens driving unit **20** that has been assembled in this way is mounted on the movable base **10** by the tilt adjusting mechanism **30**. That is, the support reference portion **21***a* of the unit chassis **21** is supported at a location between the fulcrum supporting portion **16** of the movable base **10** and the leaf spring **31**, and the adjustment screws **31***a* and **31***b* that have been inserted into two locations of the movable base **10** are screwed into the respective adjustment internally threaded holes **21***b* and **21***c* in the unit chassis **21**. The compression coil springs **32***a* and **32***b* are mounted at locations between the unit chassis **21** and the movable base **10**.

When the optical pickup device **1** is mounted on the optical disk device, as shown in FIG. **1**, the movable base **10** is supported by the guide shaft **2** and the drive screw shaft **3**.

Thereafter, a reference disk is set on the turntable of the optical disk device, and the tilt of the optical axis O of the optical pickup device **1** is adjusted. In the adjusting operation, with an abutting portion where the fulcrum supporting portion **16** and the support reference portion **21***a* contact each other serving as a fulcrum, the unit chassis **21** is tilted around a Rad axis by adjusting the tightening amount of the adjustment screw **31***a*. In addition, with the abutting portion where the fulcrum supporting portion **16** and the support reference portion **21***a* contact each other serving as a fulcrum, the unit chassis **21** is tilted around a Tan axis by adjusting the tightening amount of the adjustment screw **31***b*. By these adjustments, the opposing angle between the reference disk and the optical axis O of the lens driving unit **20** is adjusted.

As shown in FIG. **3**, the stopper protrusions **13** at the bottom portion of the movable base **10** are inserted into the corresponding openings **21***f* formed in the unit chassis **21**, so that the stopper portions **13***a* at the upper ends of the stopper portions **13** protrude above the receiving portions **21***d* of the unit chassis **21**.

FIG. **3** illustrates a state in which the lens holder **25** is resiliently supported at a neutral position by the resilient wires **24** when an external force does not act upon the lens holder **25**. At this time, the restricting abutting portions **25***a* at the bottom portion of the lens holder **25** and the stopper portions **13***a* of the movable base **10** are separated from each other by a distance H**1** in the optical-axis direction (F direction). The opposing abutting portions **25***c* of the lens holder **25** and the receiving portions **21***d* of the unit chassis **21** are separated from each other by a distance H**2**. The distance H**2** is larger than the distance H**1**.

Next, the operation of the optical pickup device **1** is described.

When an optical disk is placed on the turntable of the optical disk device, the turntable rotates and, thus, the optical disk rotates. First, the focus correcting mechanism causes the lens holder **25** to move downward by approximately 1 mm in a direction away from the optical disk (that is, a downward direction in FIG. **1**). When the light emitting element emits detection light, which is laser light, the detection light is reflected by a prism **15** and is caused to converge towards the optical disk by the objective lens **27**. When the detection light is focused on a recording surface of the optical disk, reflected light thereof returns along the optical axis O of the objective lens **27** and this returning light is detected by the light receiving element. By monitoring whether or not the reflected light is detectable while raising the lens holder **25** by the focus correcting mechanism, for example, a determination is made as to whether or not an optical disk is placed on the turntable, or the type of optical disk, such as a CD or a DVD, is determined.

When it is detected that an optical disk is placed on the turntable and the type of optical disk is determined, the optical disk is rotationally driven and, for example, image data is read. At this time, the focus correcting mechanism performs a focus correction operation in which the lens holder **25** is slightly driven in a direction F to constantly focus the detection light on the recording surface of the optical disk. The tracking correcting mechanism performs a tracking correction operation in which the lens holder **25** is slightly driven in a radial direction (Rad), and a spot where the detection light is focused follows a recording track of the optical disk.

As described above, the lens holder **25** is driven in an optical-axis direction (F) by the focus driving mechanism. During the operation, the lens holder **25** may be moved downward by an amount that is more than necessary due to an erroneous focus correction operation. In addition, the lens holder **25** may also be moved downward by an amount that is more than necessary when the lens holder **25** is subjected to a large downward acceleration.

At this time, as shown in FIG. **4**, the restricting abutting portions **25***a* at the bottom portion of the lens holder **25** come into contact with the stopper portions **13***a* at the upper ends of the stopper protrusions **13** that are provided at the movable base **10**, so that further downward movement of the lens holder **25** is restricted. Therefore, it is possible to prevent the resilient wires **24** from becoming excessively bent, so that it is possible to prevent the resilient wires **24** from undergoing plastic deformation and metal fatigue.

In FIG. **3**, the distance H**1** between each restricting abutting portion **25***a* and its corresponding stopper portion **13***a* is shorter than the distance H**2** between each opposing abutting portion **25***c* and its corresponding receiving portion **21***d*. Therefore, when the lens holder **25** moves downward, each opposing abutting portion **25***c* of the lens holder **25** also moves closer to its corresponding receiving portion **21***d* of the unit chassis **21**; and, as shown in FIG. **4**, when each restricting abutting portion **25***a* and its corresponding stopper portion **13***a* come into contact with each other, the opposing abutting portions **25***c* and the receiving portions **21***d* are kept separated by a distance δ. δ=H**2**−H**1**.

As shown in FIG. **4**, even if the lens holder **25** is moved maximally downward in a direction away from the optical disk, the lens holder **25** is always separated from the unit chassis **21** without contacting the unit chassis **21**. As mentioned above, in assembling the lens driving unit **20**, after mounting the supporting member **22**, the supporting substrate **23**, and the resilient wires **24** at the unit chassis **21**, the lens holder **25** is positioned and the resilient wires **24** and the metallic supporting terminals **26** are soldered to each other. During the soldering, flux may adhere to, for example, the receiving portions **21***d* of the unit chassis **21**. When the flux adhered to the unit chassis **21** is used in a high-temperature environment, the flux exhibits adhesiveness and may temporarily adhere to and hold the lens holder **25** that has moved downward.

However, as shown in FIG. **4**, even if the lens holder **25** moves downward by a maximum distance, the lens holder **25** is kept separated from the unit chassis **21**. Therefore, even in a high-temperature environment, the lens holder **25** does not adhere to the unit chassis. Consequently, it is possible to smoothly move the lens holder **25** upward and downward in the optical-axis direction (the direction F) and to reduce the possibility of occurrences of error in detecting the presence or absence of the optical disk and in detecting the type of optical disk.

Next, as shown in FIG. **1**, when the lens driving unit **20**, where the lens holder **25** is mounted on the unit chassis **20**, is stored and transported before being mounted on the movable base **10**, external force may accidentally be applied to the lens holder **25**. However, even if this force moves the lens holder **25** downward, since the opposing abutting portions **25***c* do not contact the corresponding receiving portions **21***d* of the unit chassis **21**, it is possible to prevent the resilient wires **24** from becoming excessively bent. In addition, even if flux adheres to the receiving portions **21***d*, the lens holder **25** does not adhere to the receiving portions **21***d* even if the environment is a high-temperature environment.

In the embodiment according to the present invention, as shown in FIG. **3**, when the lens holder **25** is in the neutral position, the distance H**1** between each restricting abutting portion **25***a* and its corresponding stopper portion **13***a* is shorter than the distance H**2** between each opposing abutting portion **25***c* and its corresponding receiving portion **21***d*. Therefore, when the optical pickup device **1** is operating, even if the lens holder **25** moves downward, the lens holder **25** does not come into contact with the unit chassis **21**. Consequently, even if flux adheres to the receiving portions **21***d* of the unit chassis **21**, the lens holder **25** does not adhere to the unit chassis **21** in a high-temperature environment. However, when the lens driving unit **20** is controlled as a single unit, since the opposing abutting portions **25***c* of the lens holder **25** oppose the unit chassis **21**, excessive bending of the resilient wires **24** caused when the opposing abutting portions **25***c* come into contact with the unit chassis **21** as a result of a downward force being accidentally applied to the lens holder **25** can be prevented.

In order to cause the resilient wires **24** to function in an optimal state at all times, the distance H**2** between each opposing abutting portion **25***c* and its corresponding receiving portion **21***d* shown in FIG. **3** needs to be within a range in which the bending deformation amount of the resilient wires **24** when the lens holder **25** has been moved downward to this position at the distance H**2** does not exceed a resilience region, that is, a yield point. However, if safety is considered, it is desirable that, when the lens holder **25** is moved by the distance H**2**, the distance H**2** is set such that the bending deformation stress of the resilient wires **24** is less than or equal to ⅓ of the yield point.

In the embodiment shown in FIGS. **3** and **4**, although the stopper protrusions **13** protrude upward from the movable base **10** and end portions of the stopper protrusions **13** are the stopper portions **13***a*, it is possible for the stopper portions **13***a* to be provided at the flat bottom portion of the movable base **10** and for the restricting abutting portions **25***a* to protrude downward from the lens holder **25**.

In addition, it is possible to provide the unit chassis **21** with a suppressing portion that suppresses excessive upward movement (that is, excessive movement towards the optical disk) of the lens holder **25**.

While there has been illustrated and described what is at present contemplated to be preferred embodiments of the present invention, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the invention. In addition, many modifications may be made to adapt a particular situation to the teachings of the invention without departing from the central scope thereof. Therefore, it is intended that this invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. An optical pickup device comprising:

a movable base; and

a lens driving unit that is supported by the movable base,

wherein the lens driving unit includes a unit chassis, a lens holder, a resilient supporting member, and a focus correcting mechanism;

the lens holder, the resilient supporting member, and the focus correcting mechanism being provided at the unit chassis;

the lens holder holding an objective lens that opposes a recording medium; the resilient supporting member supporting the lens holder;

the focus correcting mechanism moving the lens holder in a direction of an optical axis of the objective lens,

wherein the lens holder includes a restricting abutting portion and an opposing abutting portion,

wherein, when the lens holder moves in a direction away from the recording medium, the restricting abutting portion comes into contact with the movable base to restrict further movement of the lens holder, and

wherein, when the lens holder moves in the direction away from the recording medium, the opposing abutting portion moves closer to the unit chassis, and, when the restricting abutting portion comes into contact with the movable base, the opposing abutting portion opposes the unit chassis with a gap between the opposing abutting portion and the unit chassis.

2. The optical pickup device according to claim **1**, wherein a positional relationship between the opposing abutting portion and the unit chassis is determined such that, when the opposing abutting portion and the unit chassis come into contact with each other in a state in which the lens driving unit is not mounted on the movable base, an amount of deformation of the resilient supporting member is within a resilience region of the resilient supporting member.

3. The optical pickup device according to claim **1**, wherein a plurality of resilient supporting members are provided, the plurality of resilient supporting members being a plurality of resilient wires that extend in a direction that crosses the direction of the optical axis,

wherein a base portion of each resilient wire is secured at the unit chassis, and

wherein an end portion of each resilient wire and the lens holder are soldered and secured to each other.

4. The optical pickup device according to claim **3**, wherein, in a state in which the base portion of each resilient wire is secured at the unit chassis, the lens holder is positioned at the unit chassis, and the end portion of each resilient wire and the lens holder are soldered to each other.

5. The optical pickup device according to claim **1**, wherein the movable base includes a stopper protrusion that comes into contact with the restricting abutting portion,

wherein the unit chassis includes a receiving portion that opposes the opposing abutting portion, and

wherein an end portion of the stopper protrusion is positioned closer to the lens holder than the receiving portion.

6. The optical pickup device according to claim **1**, further comprising a tilt adjusting mechanism that is disposed between the movable base and the unit chassis, the tilt adjusting mechanism adjusting an amount of tilt of the optical axis of the objective lens.

7. An optical pickup device comprising:

a movable base; and

a lens driving unit that is supported by the movable base,

wherein the lens driving unit includes a unit chassis, a lens holder, a plurality of resilient supporting members, and a focus correcting mechanism;

the lens holder, the resilient supporting members, and the focus correcting mechanism being provided at the unit chassis;

the lens holder holding an objective lens that opposes a recording medium;

the resilient supporting members supporting the lens holder;

the focus correcting mechanism moving the lens holder in a direction of an optical axis of the objective lens,

wherein the lens holder includes a restricting abutting portion and an opposing abutting portion,

wherein, when the lens holder moves in a direction away from the recording medium, the restricting abutting portion comes into contact with the movable base to restrict further movement of the lens holder, and

wherein, when the lens holder moves in the direction away from the recording medium, the opposing abutting portion moves closer to the unit chassis, and, when the restricting abutting portion comes into contact with the movable base, the opposing abutting portion opposes the unit chassis with a gap between the opposing abutting portion and the unit chassis.

8. The optical pickup device according to claim **7**, wherein a positional relationship between the opposing abutting portion and the unit chassis is determined such that, when the opposing abutting portion and the unit chassis come into contact with each other in a state in which the lens driving unit is not mounted on the movable base, an amount of deformation of the resilient supporting member is within a resilience region of the resilient supporting members.

9. The optical pickup device according to claim **7**, wherein the plurality of resilient supporting members are a plurality of resilient wires that extend in a direction that crosses the direction of the optical axis,

wherein a base portion of each resilient wire is secured at the unit chassis, and

wherein an end portion of each resilient wire and the lens holder are soldered and secured to each other.

10. The optical pickup device according to claim **9**, wherein, in a state in which the base portion of each resilient wire is secured at the unit chassis, the lens holder is positioned at the unit chassis, and the end portion of each resilient wire and the lens holder are soldered to each other.

11. The optical pickup device according to claim **7**, wherein the movable base includes a stopper protrusion that comes into contact with the restricting abutting portion,

wherein the unit chassis includes a receiving portion that opposes the opposing abutting portion, and

wherein an end portion of the stopper protrusion is positioned closer to the lens holder than the receiving portion.

12. The optical pickup device according to claim **7**, further comprising a tilt adjusting mechanism that is disposed between the movable base and the unit chassis, the tilt adjusting mechanism adjusting an amount of tilt of the optical axis of the objective lens.

13. An optical pickup device comprising:

a movable base; and

a lens driving unit that is supported by the movable base,

wherein the lens driving unit includes a unit chassis, a lens holder, a resilient supporting member, and a focus correcting mechanism;

the lens holder, the resilient supporting member, and the focus correcting mechanism being provided at the unit chassis;

the lens holder holding an objective lens that opposes a recording medium;

the resilient supporting member supporting the lens holder;

the focus correcting mechanism moving the lens holder in a direction of an optical axis of the objective lens,

wherein a tilt adjusting mechanism is disposed between the movable base and the unit chassis, the tilt adjusting mechanism adjusting an amount of tilt of the optical axis of the objective lens,

wherein the lens holder includes a restricting abutting portion and an opposing abutting portion,

wherein, when the lens holder moves in a direction away from the recording medium, the restricting abutting portion comes into contact with the movable base to restrict further movement of the lens holder,

wherein, when the lens holder moves in the direction away from the recording medium, the opposing abutting portion moves closer to the unit chassis, and, when the restricting abutting portion comes into contact with the movable base, the opposing abutting portion opposes the unit chassis with a gap between the opposing abutting portion and the unit chassis, and

wherein a positional relationship between the opposing abutting portion and the unit chassis is determined such that, when the opposing abutting portion and the unit chassis come into contact with each other in a state in which the lens driving unit is not mounted on the movable base, an amount of deformation of the resilient supporting member is within a resilience region of the resilient supporting member.

14. The optical pickup device according to claim **13**, wherein a plurality of resilient supporting members are provided, the plurality of resilient supporting members being a plurality of resilient wires that extend in a direction that crosses the direction of the optical axis,

wherein a base portion of each resilient wire is secured at the unit chassis, and

wherein an end portion of each resilient wire and the lens holder are soldered and secured to each other.

15. The optical pickup device according to claim **14**, wherein, in a state in which the base portion of each resilient wire is secured at the unit chassis, the lens holder is positioned at the unit chassis, and the end portion of each resilient wire and the lens holder are soldered to each other.

16. The optical pickup device according to claim **13**, wherein the movable base includes a stopper protrusion that comes into contact with the restricting abutting portion,

wherein the unit chassis includes a receiving portion that opposes the opposing abutting portion, and

wherein an end portion of the stopper protrusion is positioned closer to the lens holder than the receiving portion.

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